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Environmental sustainability in health technology assessment (HTA)

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www.yhec.co.uk

Key messages for today

- Environmental impacts affects human health, contributing to disease burden
- Healthcare contributes sizeable environmental impact
- Approaches to sustainable development in health technology assessment and economic evaluation
- Challenges faced include data limitations, internal resource constraints and how do we “trade off” and balance appropriate decision making in terms of including environmental outcomes
- Life cycle assessment (LCA) is an important framework and the broader impacts of health technology need to be included in the LCA model

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Brief overview of environmental sustainability at York Health Economics Consortium (YHEC)

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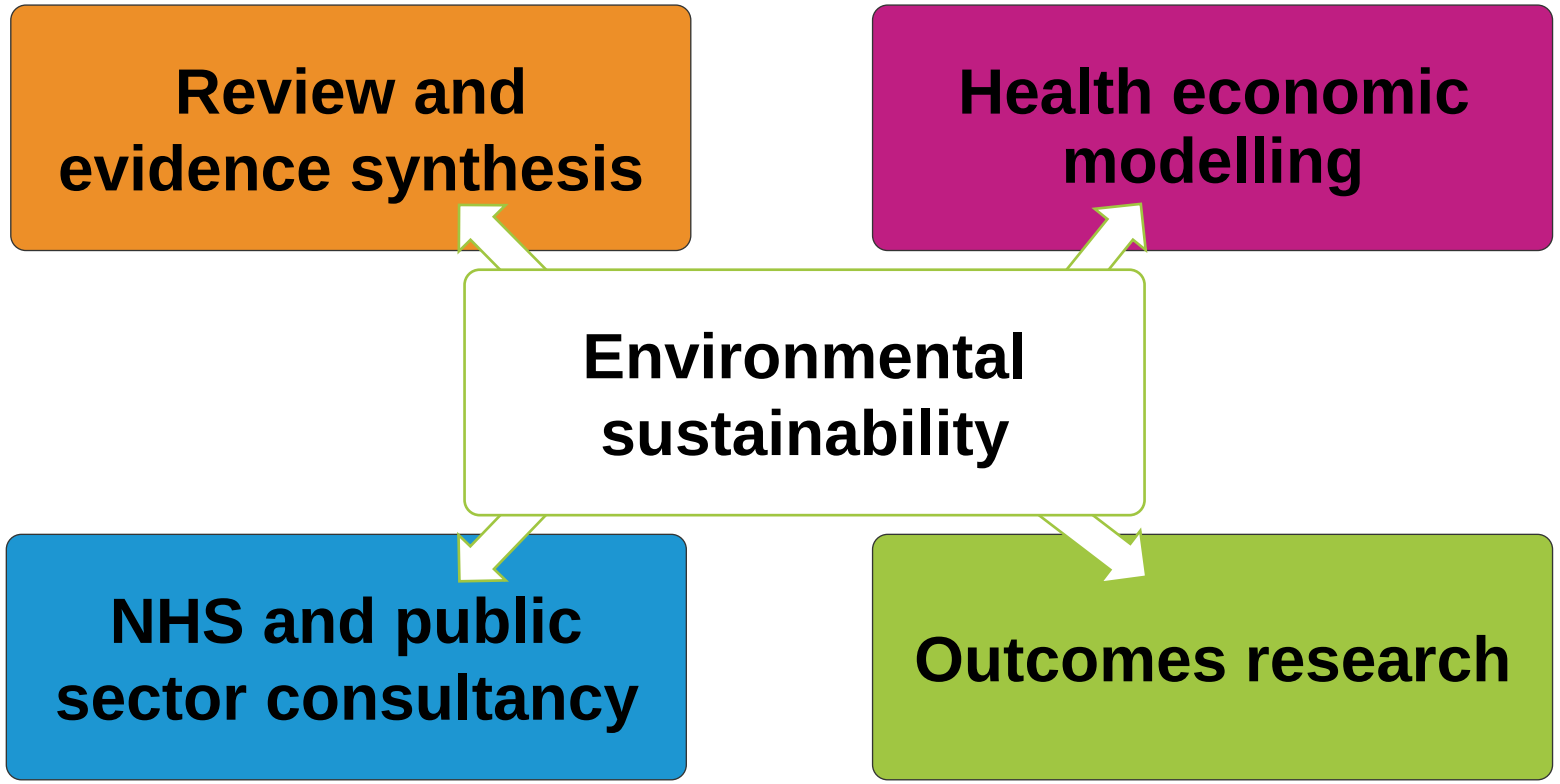
YHEC's in-house environmental sustainability team provides support across all workstreams



Environmental sustainability services

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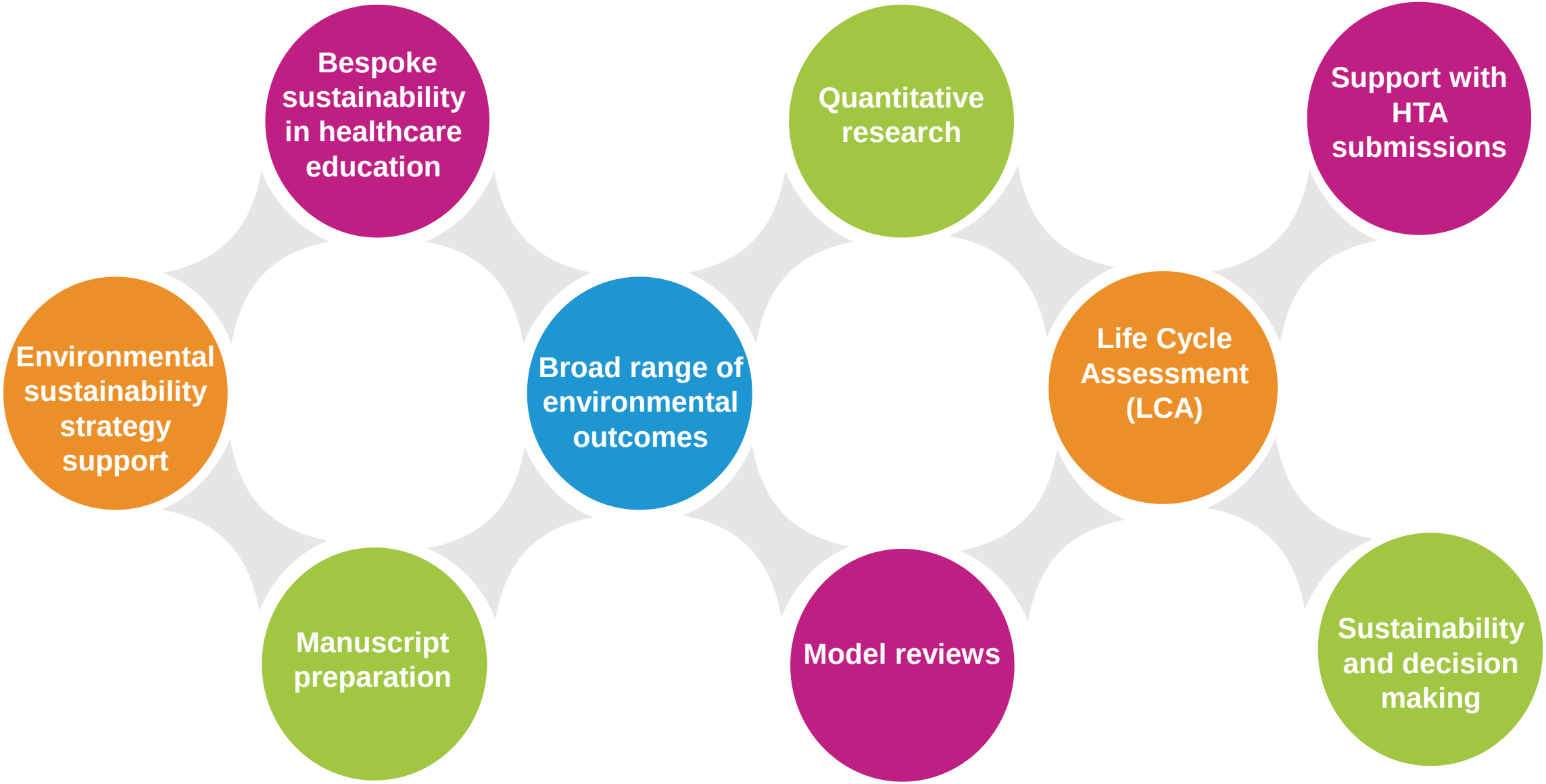

Carbon dioxide equivalents (CO2e) – a common single unit of expression

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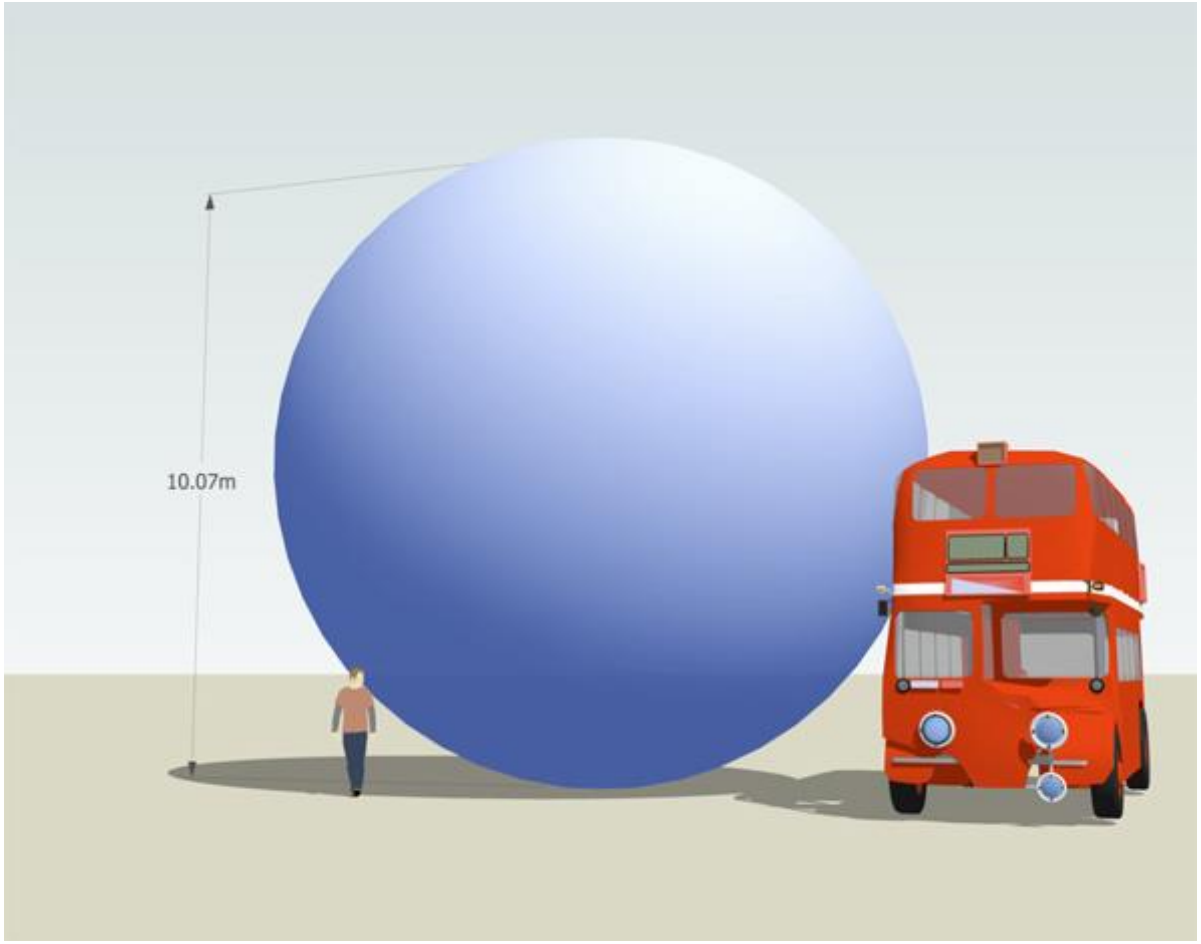
Carbon dioxide equivalent (CO2e)



Source: *The Earthbound Report 2012*

Greenhouse Gas	Global Warming Potential (GWP)
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_2O)	298
Hydrofluorcarbons (HFCs)	124 – 14,800
Perfluorocarbons (PFCs)	7,390 – 12,200
Sulfur hexafluoride (SF_6)	22,800
Nitrogen trifluoride (NF_3)	17,200

Source: International Panel on Climate Change 2007 report (Solomon et al., 2007)

How does environmental health affect human health?

- During summer 2022, an estimated 2,985 (2,258 to 3,712) and 62K all-cause excess heat related deaths in the UK and Europe, respectively (Ballester et al., 2023)
- Air pollution is linked to over 9 million (12%) deaths globally a year (Fuller et al., 2022)
- Within the past 50 years wildlife numbers have plunged by 69% (WWF Living Planet Report 2022) including a 45% decline in insect abundance
- The UK Environment Agency warns that by 2040, the number of seriously water stressed regions is on course to rise to 12, out of a total of 17 (Kingfisher 2023)
- A Canadian study reports the healthcare system generates 33 million tonnes of CO2e per/yr as well as >200,000 tonnes of other pollutants linked to 23,000 DALYs lost per/yr from healthcare pollution (Eckelman et al., 2018)

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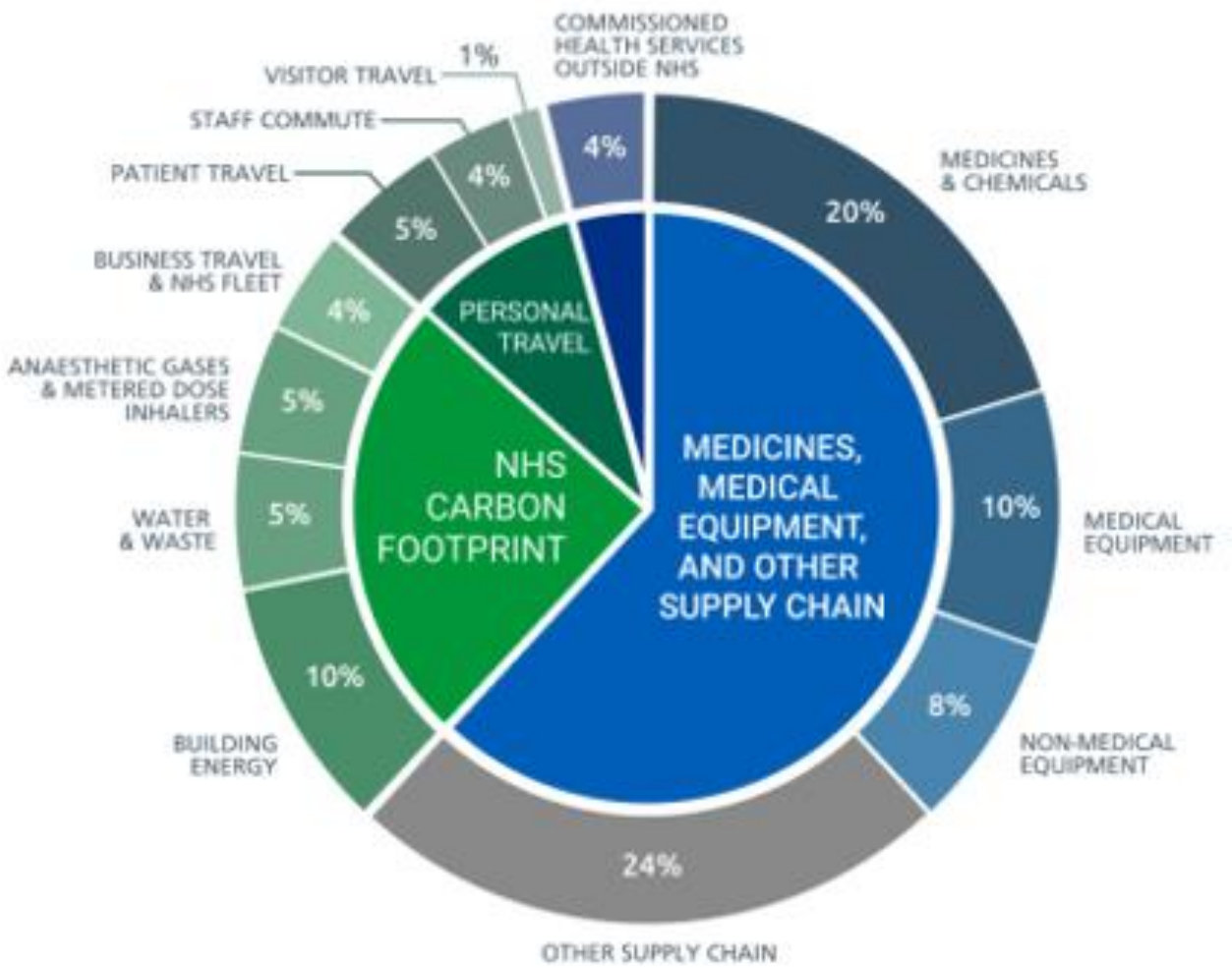
Healthcare's environmental footprint and environmental targets

Healthcares' environmental footprint

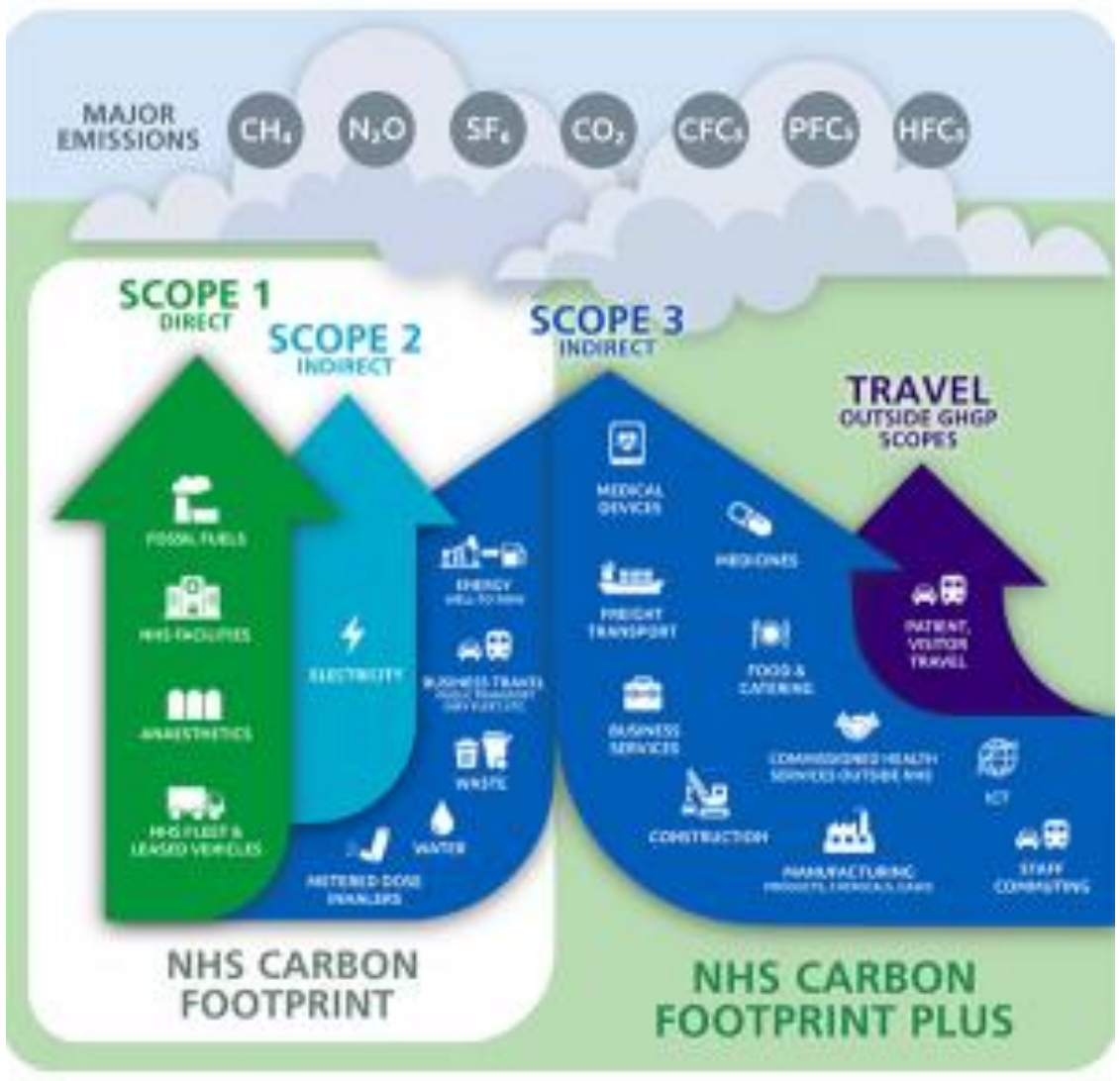


Source: carbon emissions by proportion of NHS Carbon Footprint Plus (2022)

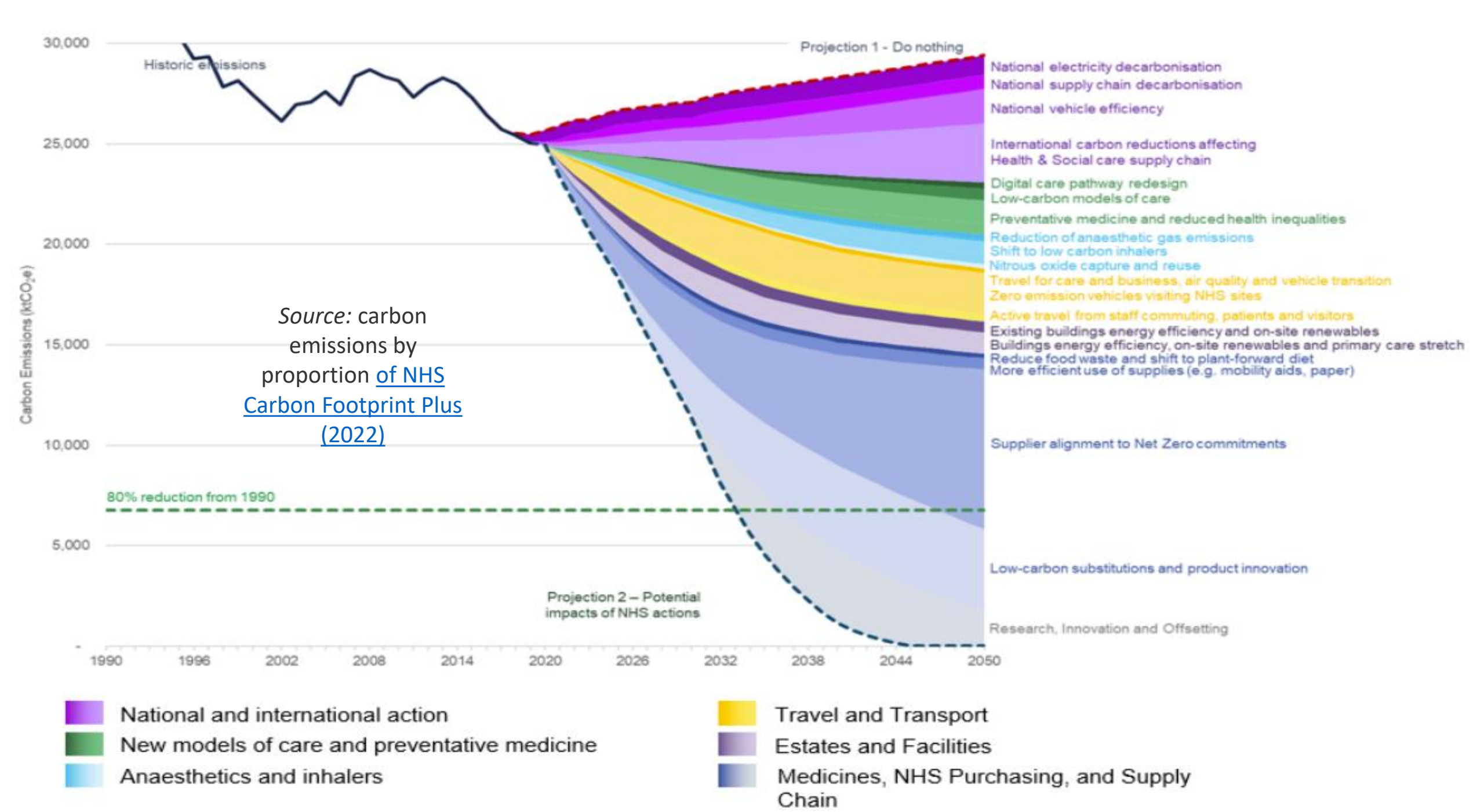
- NHS supply chain contributes largest footprint (almost two-thirds) of which pharmaceuticals and chemicals (20% total) and medical equipment (10% total) were biggest contributors
- 20% of carbon emissions in the NHS is attributable to the life cycle of pharmaceuticals (NHS 2022)
- The NHS in England generates approximately 538,600 tonnes of waste per year equating to 20% financial expenditure (NHS 2022)
- England = 24.9 Million tonnes CO2e, 4.4% of national GHG emissions – equivalent to whole of Croatia (NHS 2022)
- Healthcare emissions represent as a country the 5th largest worldwide (Tennison et al., 2021)

National Health Service (NHS) net zero targets

- In 2020 UK NHS first health system to set an ambition of net zero:
  - **scope 1 + scope 2 by 2040**
  - **scope 3 by 2045**
- All trusts and ICSs have Green Plans in place
- In 2022, social value in central government contracts making a weighting of 10% for net zero + social value compulsory
- From April 2024, all NHS procurements must have a Carbon Reduction Plan
- From 2030 suppliers will only be able to qualify for NHS contracts if they can demonstrate their progress through published progress reports



Source: Greenhouse gas protocol scopes in the context of the NHS



Source: carbon emissions by proportion [of NHS Carbon Footprint Plus (2022)]

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Healthcare environmental sustainability framework development

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Sustainability in healthcare

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Sustainability is defined as ***"meeting the needs of the present without compromising the ability of future generations to meet their own needs."*** (Brundtland 1987)

[THE 17 GOALS | Sustainable Development (un.org)]

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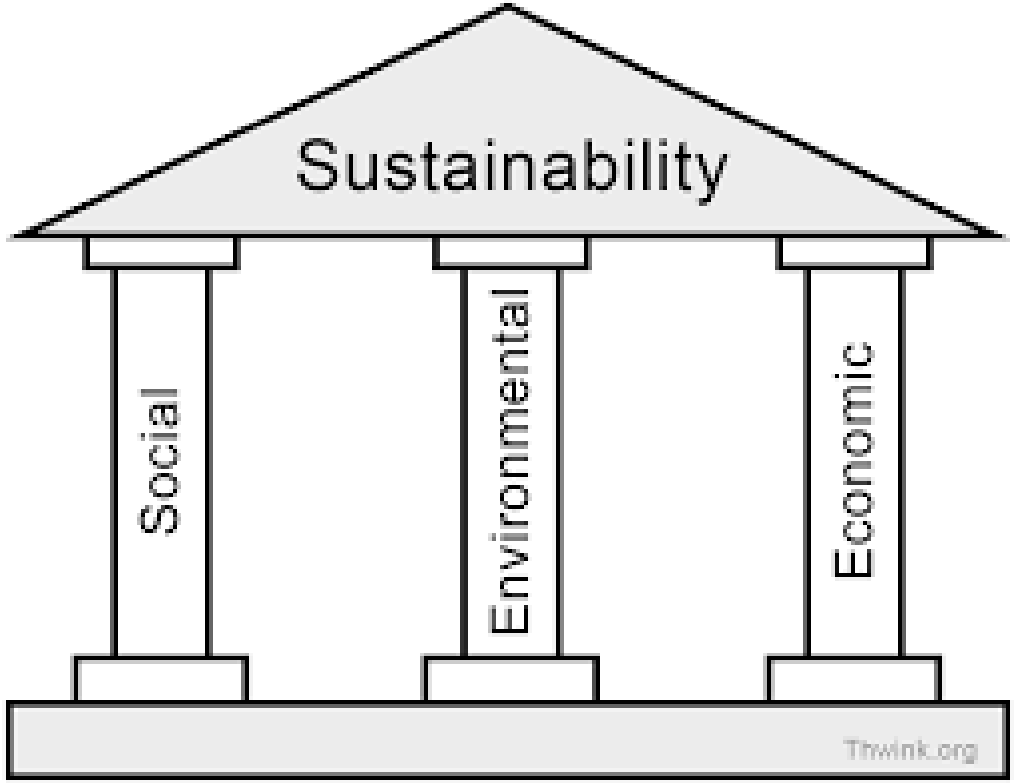

What about developments in HTA?

- Research into approaches and methods of assessment are starting to emerge from authors based within HTA organisations and stakeholders globally
- Several HTA organisations and agencies globally are starting to prioritise sustainability as part of their review process including The UK (NICE), Health Improvement Scotland (HIS) and Canada's Drug and Health Technology Agency (CADTH)
- In 2018, CADTH undertook a first parallel assessment alongside a CEA: the environmental assessment was approached from a risk viewpoint
- In 2021, the NICE pledged to explore ways to incorporate environmental impact data in their guidance (NICE 2021)
- NICE recently published a report exploring public opinion on their role in making healthcare more environmentally sustainable (NICE 2023)
- I undertook the first parallel assessment alongside a CEA of single use device versus reusable for Health Improvement Scotland (due to be published soon)
- No HTA reference manuals currently state the inclusion of environmental impacts
- Challenges faced; resources constraints, data availability and competing priorities

Canada's Drug and Health technology Agency (CADTH) Environmental Horizon Scan (CADTH 2023)

- Opportunities to reduce health care's environmental impact; appropriate use of health care, reducing unnecessary health care, and rethinking and researching what and how health care is provided
- Healthcare initiatives identified include operating rooms and surgical services, anaesthetics services, dialysis, virtual care, and single-use medical supplies
- Multiple goals can be achieved e.g., appropriate use of metered dose inhalers = cost savings, improving patient care, and reducing the environmental impact of care
- Challenges such as the lack of data on the environmental impact of clinical interventions and devices, although opportunities for engaging health care leadership, staff, and patients to support sustainable development in healthcare
- Opportunities are to consider evidence on environmental impact alongside clinical and economic evidence, patient perspectives, social values, and ethics to support the delivery of clinically effective, cost-effective, and environmentally sustainable care

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Incorporation into decision making

What do we mean by ‘decision making’?

- Limited to assessing the environmental impact of healthcare *decisions*
  - Approving a new drug
  - Approving a new device
  - Approving a change to the system / pathways
  - Updating a clinical guideline
  - Public health policies
  - etc.
- The impact might be (net) positive or negative

Two main approaches to including sustainability in HTA

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PARALLEL ASSESSMENT

DELIBERATIVE PROCESS

- A committee might use environmental evidence alongside other evidence
- Similar to inequalities
- Similar to innovation

CAN LEAD TO INCONSISTENCIES

- No transparency as when the environmental impact should / should not change the decision
- Likely to be a high risk of legal appeals

FULLY INTEGRATED ANALYSIS

EXPLICITLY MODIFIES THE RESULTS

- All outcomes are quantified
- Combined together to form a single result

REQUIRES A DECISION RULE

- How much health loss should be traded in order to gain one ‘unit’ of environmental benefit (and vice versa)?
- 1 QALY = ?

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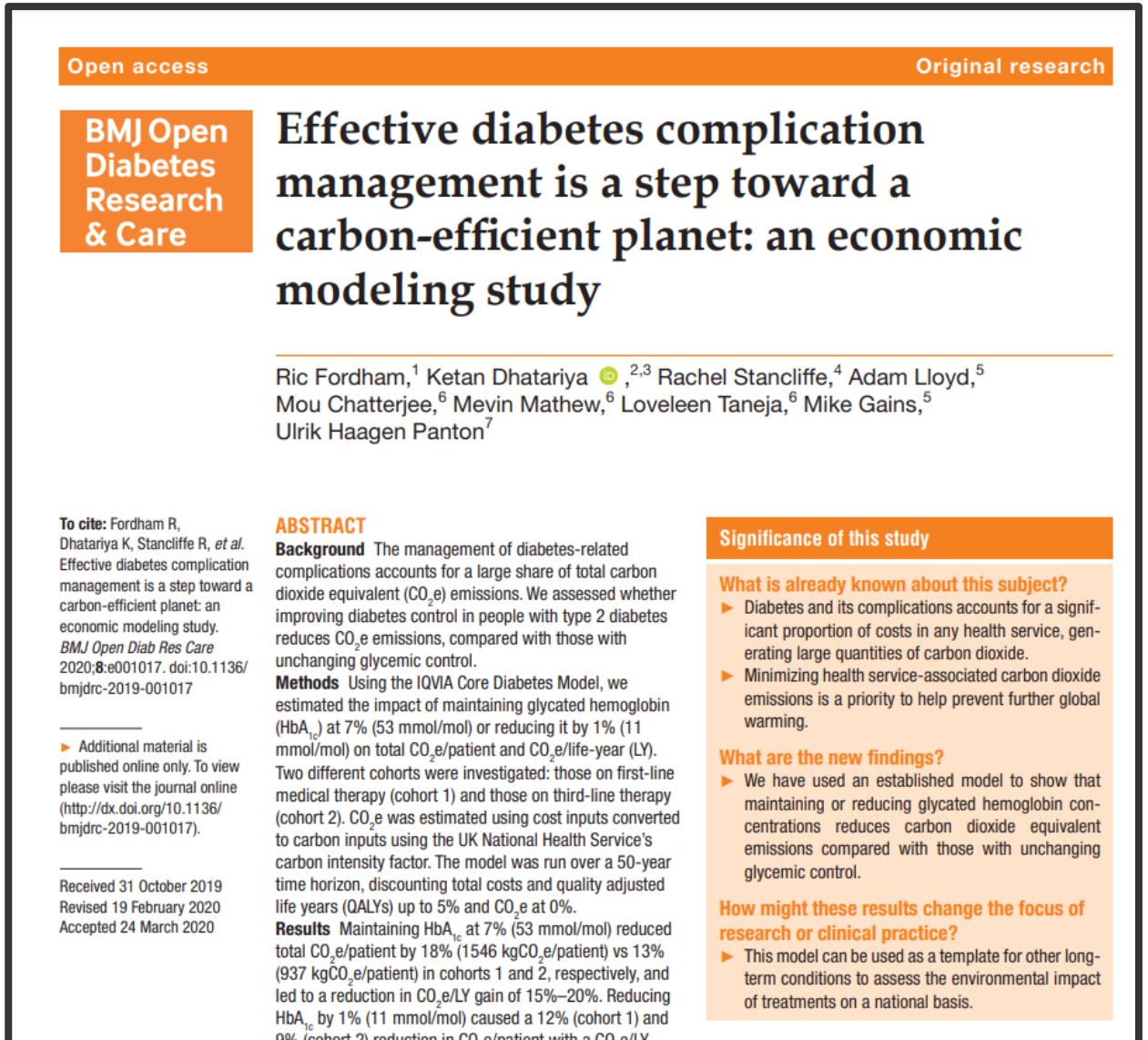
Case study: diabetes

Case study: diabetes



Open access Original research

BMJ Open Diabetes Research & Care

Effective diabetes complication management is a step toward a carbon-efficient planet: an economic modeling study

Ric Fordham,[1] Ketan Dhatariya ,[2,3] Rachel Stancliffe,[4] Adam Lloyd,[5] Mou Chatterjee,[6] Mevin Mathew,[6] Loveleen Taneja,[6] Mike Gains,[5] Ulrik Haagen Panton[7]

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► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/bmjdrc-2019-001017).

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ABSTRACT

Background The management of diabetes-related complications accounts for a large share of total carbon dioxide equivalent (CO_2e) emissions. We assessed whether improving diabetes control in people with type 2 diabetes reduces CO_2e emissions, compared with those with unchanging glycemic control.

Methods Using the IQVIA Core Diabetes Model, we estimated the impact of maintaining glycated hemoglobin (HbA_{1c}) at 7% (53 mmol/mol) or reducing it by 1% (11 mmol/mol) on total CO_2e/patient and CO_2e/life-year (LY). Two different cohorts were investigated: those on first-line medical therapy (cohort 1) and those on third-line therapy (cohort 2). CO_2e was estimated using cost inputs converted to carbon inputs using the UK National Health Service's carbon intensity factor. The model was run over a 50-year time horizon, discounting total costs and quality adjusted life years (QALYs) up to 5% and CO_2e at 0%.

Results Maintaining HbA_{1c} at 7% (53 mmol/mol) reduced total CO_2e/patient by 18% (1546 $kgCO_2e$/patient) vs 13% (937 $kgCO_2e$/patient) in cohorts 1 and 2, respectively, and led to a reduction in CO_2e/LY gain of 15%–20%. Reducing HbA_{1c} by 1% (11 mmol/mol) caused a 12% (cohort 1) and 9% (cohort 2) reduction in CO_2e/patient with a CO_2e/LY

Significance of this study

What is already known about this subject?

- Diabetes and its complications accounts for a significant proportion of costs in any health service, generating large quantities of carbon dioxide.
- Minimizing health service-associated carbon dioxide emissions is a priority to help prevent further global warming.

What are the new findings?

- We have used an established model to show that maintaining or reducing glycated hemoglobin concentrations reduces carbon dioxide equivalent emissions compared with those with unchanging glycemic control.

How might these results change the focus of research or clinical practice?

- This model can be used as a template for other long-term conditions to assess the environmental impact of treatments on a national basis.

Measured the impact of different treatments on CO_2

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- Used established model (IQVIA Core Diabetes Model)
- Estimated scenarios for different HbA_{1c} reductions (and 1st line / 3rd line)
- Attached CO_2 'payoffs' for different conditions / complications

Supplementary Table a:

Carbon footprint of diabetic complications kgCO2eq per patient per year

Complication	Based on resources and services	Alternate assessment based on costs
Myocardial infarction 1st year	1118.32	1470.74
Myocardial infarction 2nd+ years	112.14	147.49
Angina 1st year	764.64	673.78
Angina 2nd+ years	511.79	450.97
Congestive heart failure 1st year	667.30	620.47
Congestive heart failure 2nd+ years	340.15	316.28
Stroke 1st year	6773.56	1645.49
Stroke 2nd+ years	1119.80	272.03
Peripheral vascular disease 1st year	1161.69	421.53
Peripheral vascular disease 2nd+ years	1161.69	421.53
Haemodialysis 1st year	7618.27	5659.83
Haemodialysis 2nd+ years	7618.27	5659.83
Peritoneal dialysis 1st year	467.80	4720.72
Peritoneal dialysis 2nd+ years	467.80	4720.72

Source:
Sustainable Development Unit. Goods and services carbon hotspots:

Effective treatment reduces CO_2 emissions

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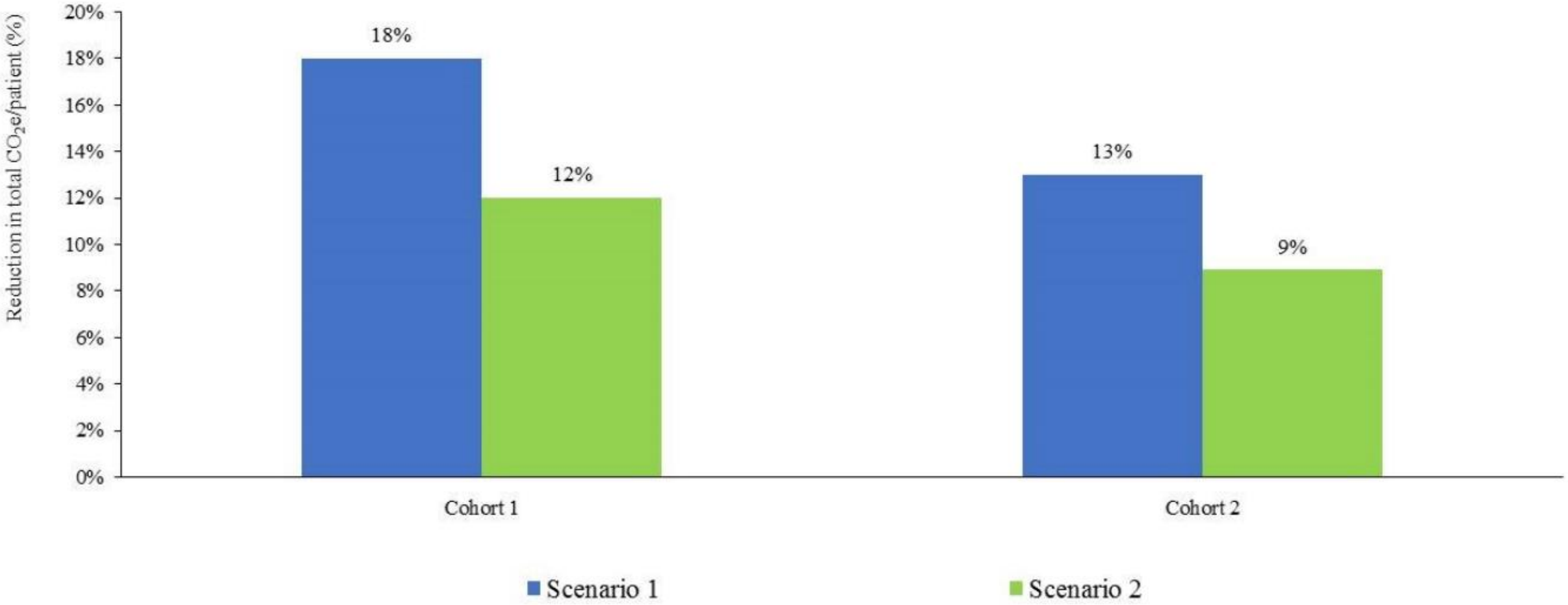

Figure 1 Reduction in total carbon emission per patient. CO_2e, carbon dioxide equivalent.

Implications and limitations of the study

- Prevention of renal complications was the largest driver of CO_2 reduction
- Did not include CO_2 impact of pharmacotherapies
- Did not account for opportunity cost (displaced therapies) impact on CO_2
- Only focussed on CO_2 emissions (i.e. not other environmental outcomes)

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journal homepage: www.elsevier.com/locate/etap

Review

Metformin environmental exposure: A systematic review

Eliane Papa Ambrosio-Albuquerque [a,*], Luis Fernando Cusioli [b], Rosângela Bergamasco [b], Adriana Aparecida Sinópolis Gigliolli [a], Luara Lupepsa [c], Brennda Ribeiro Paupitz [c], Pablo Américo Barbieri [c], Luciana Andreia Borin-Carvalho [a], Ana Luiza de Brito Portela-Castro [a]

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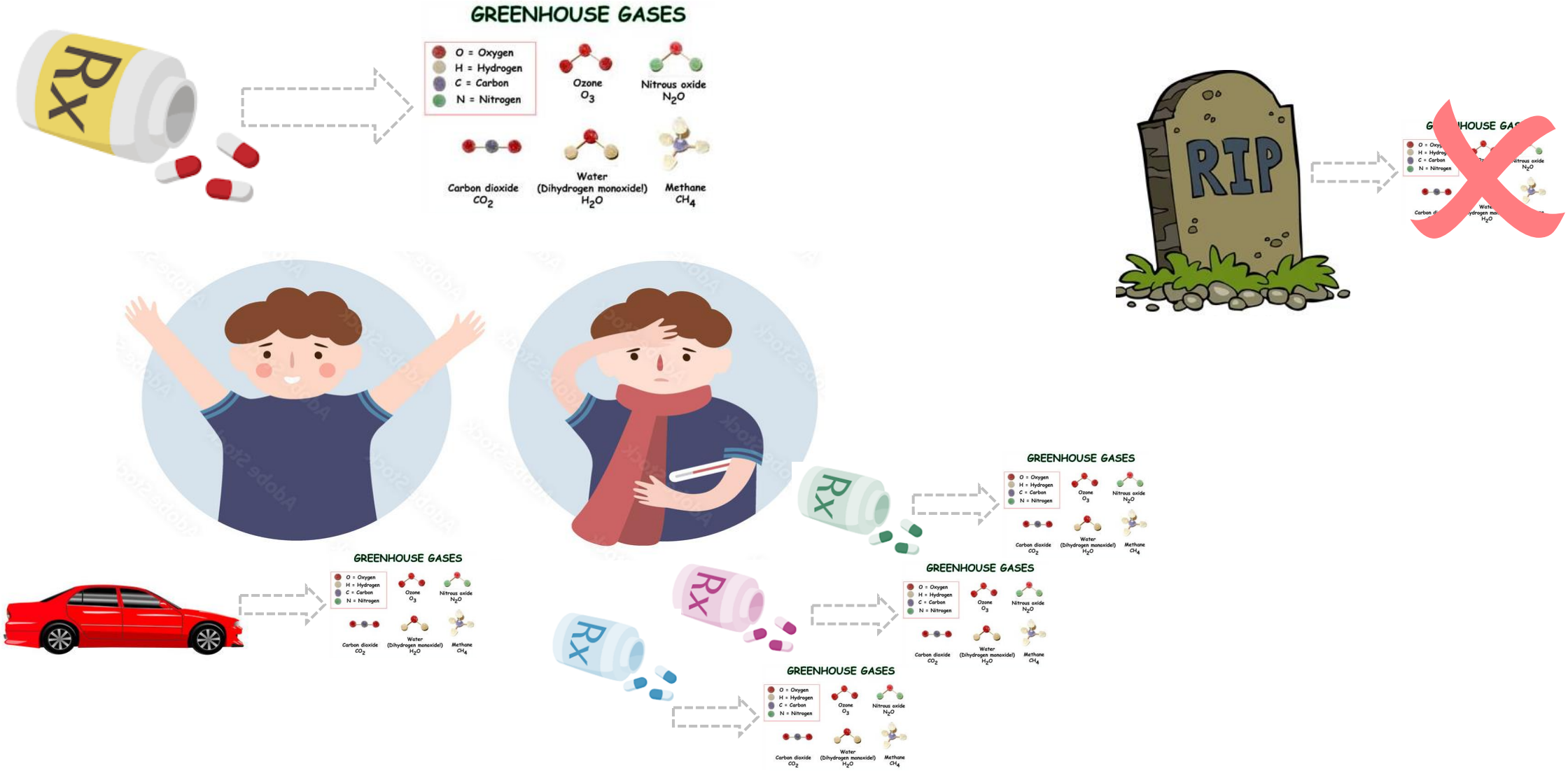
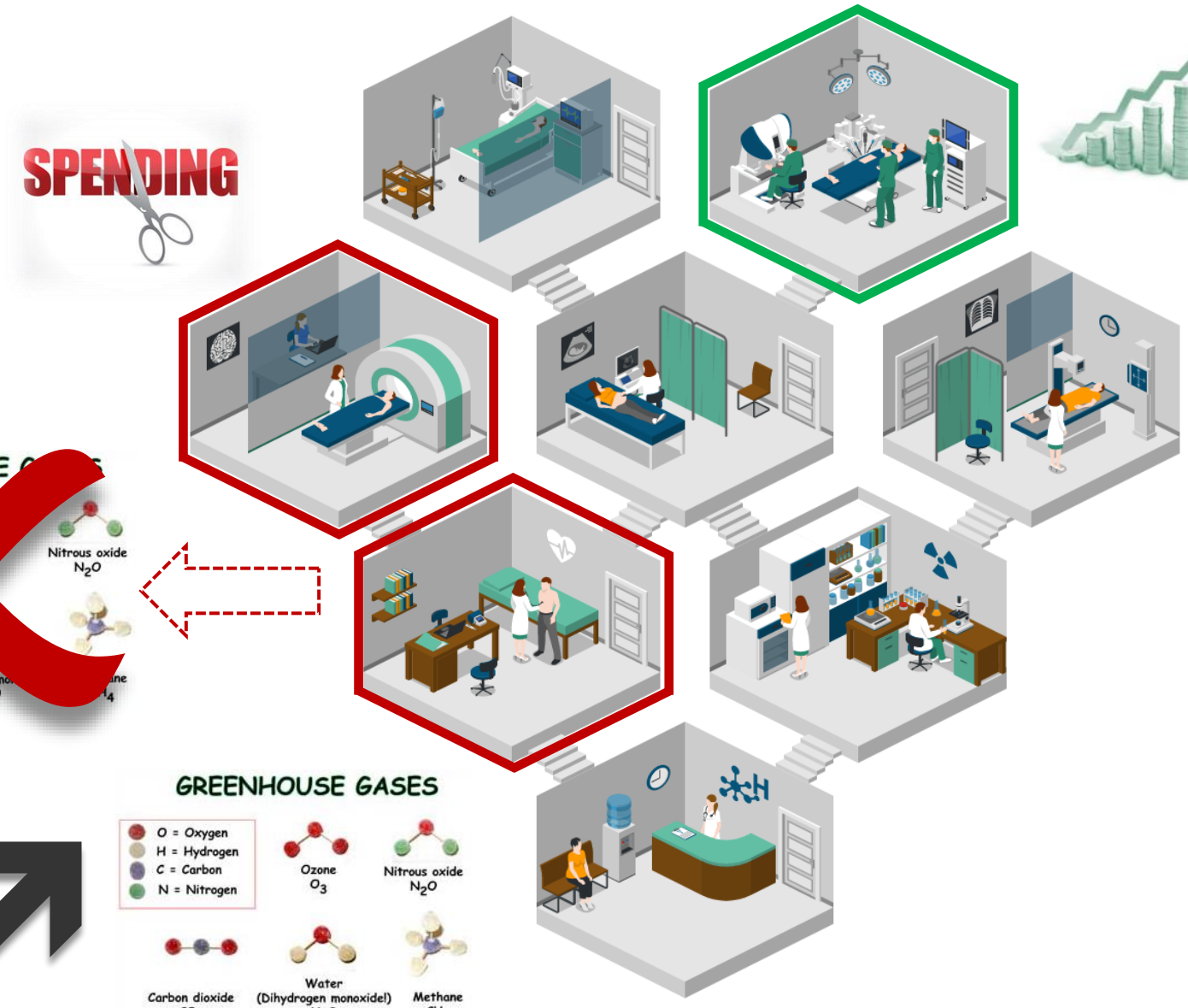
Measuring the *real* impact on the environment



Opportunity cost impact for the environment



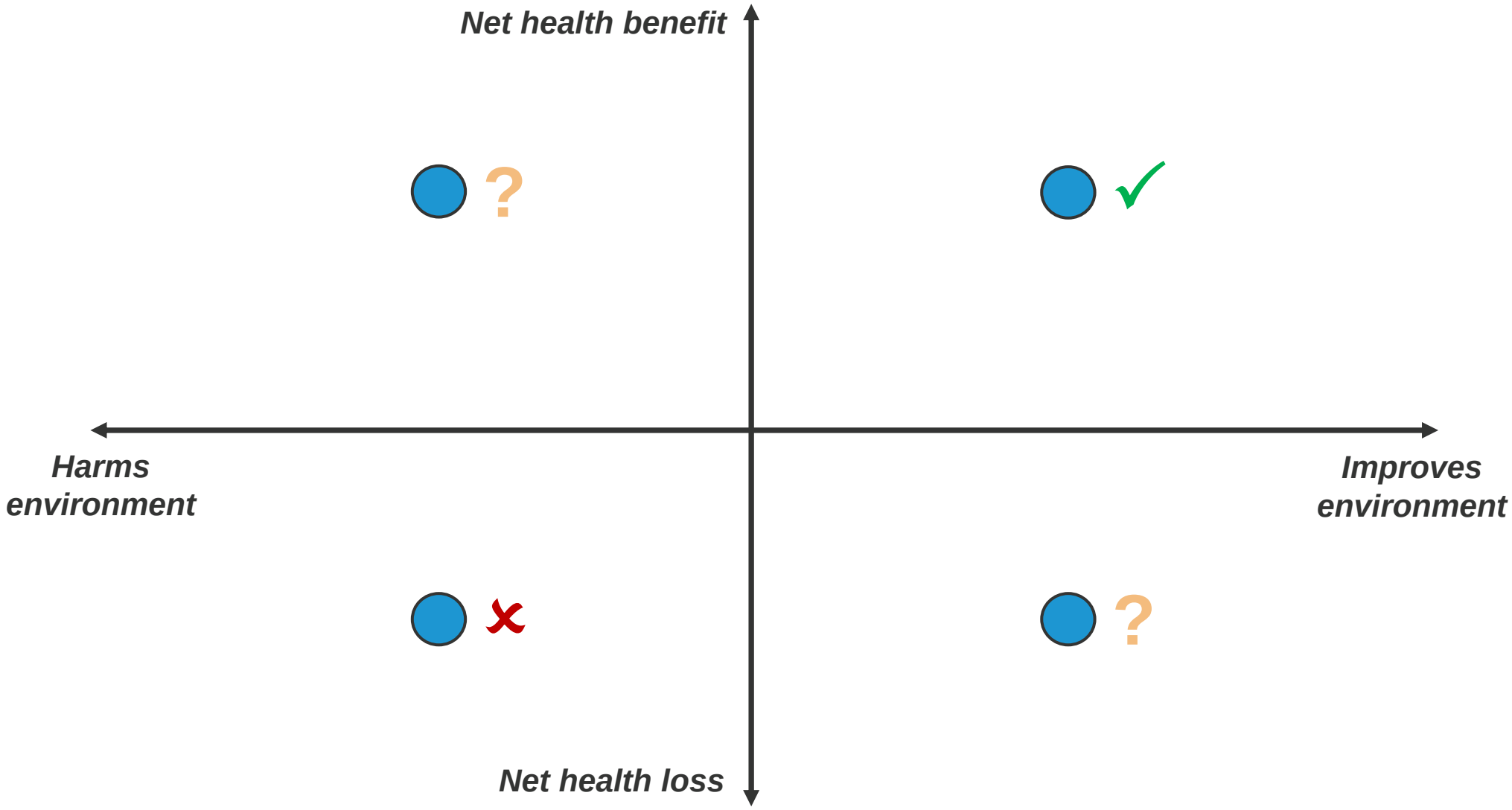
Making interventions more environmentally friendly will have an adverse impact on human health…

	More cost effective	Less cost effective
Replace by a different technology	Why weren't we doing this anyway??	We are trading off population health

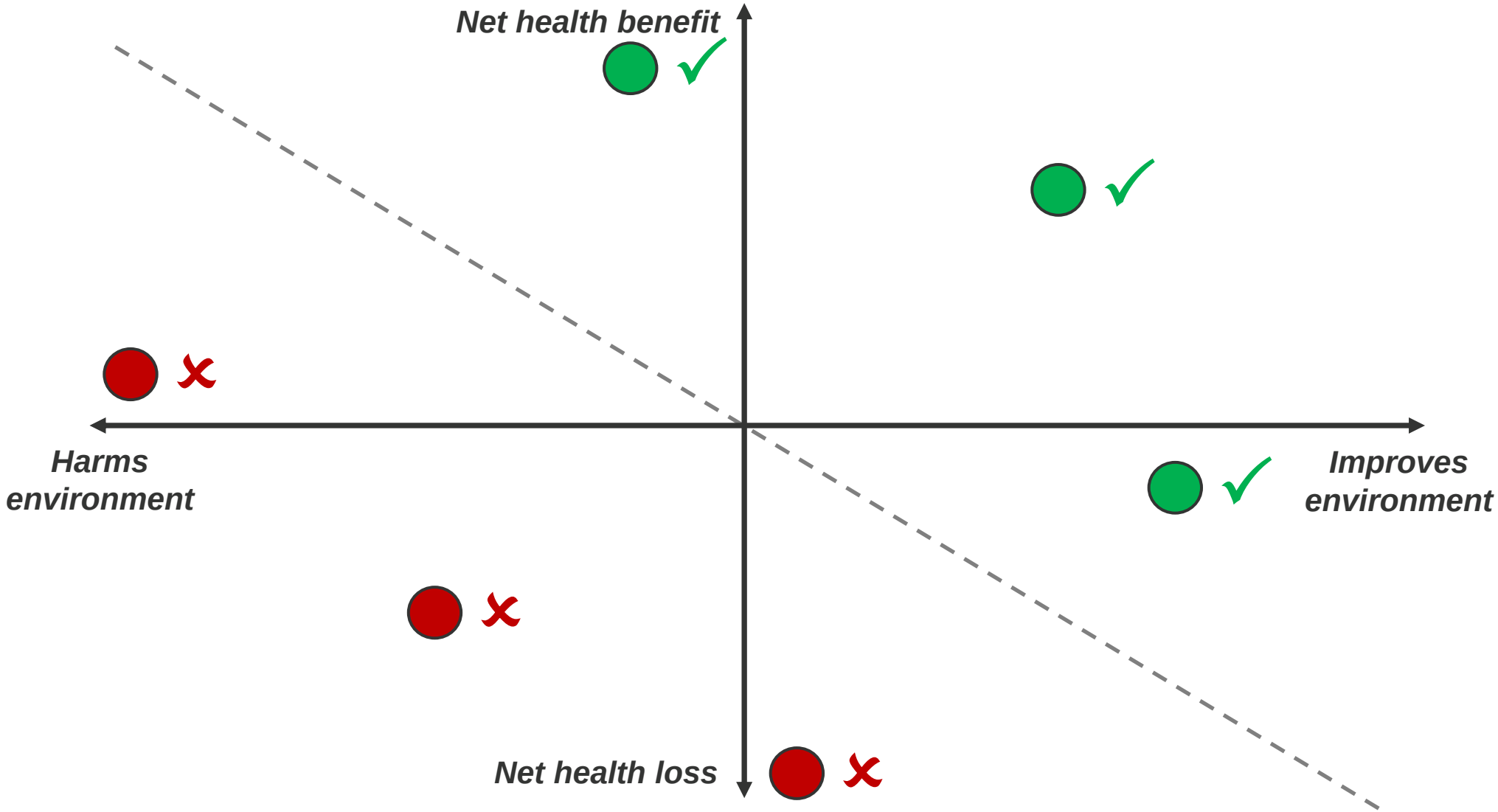
	Decreases costs	Increases costs
Change the manufacturing / disposal process	Why weren't we doing this anyway??	Price increase means more opportunity costs (lower population health)

**Assuming that the costs fall to the manufacturer or the health system.*
If the costs fall outside the health system, this doesn't need HTA decisions.

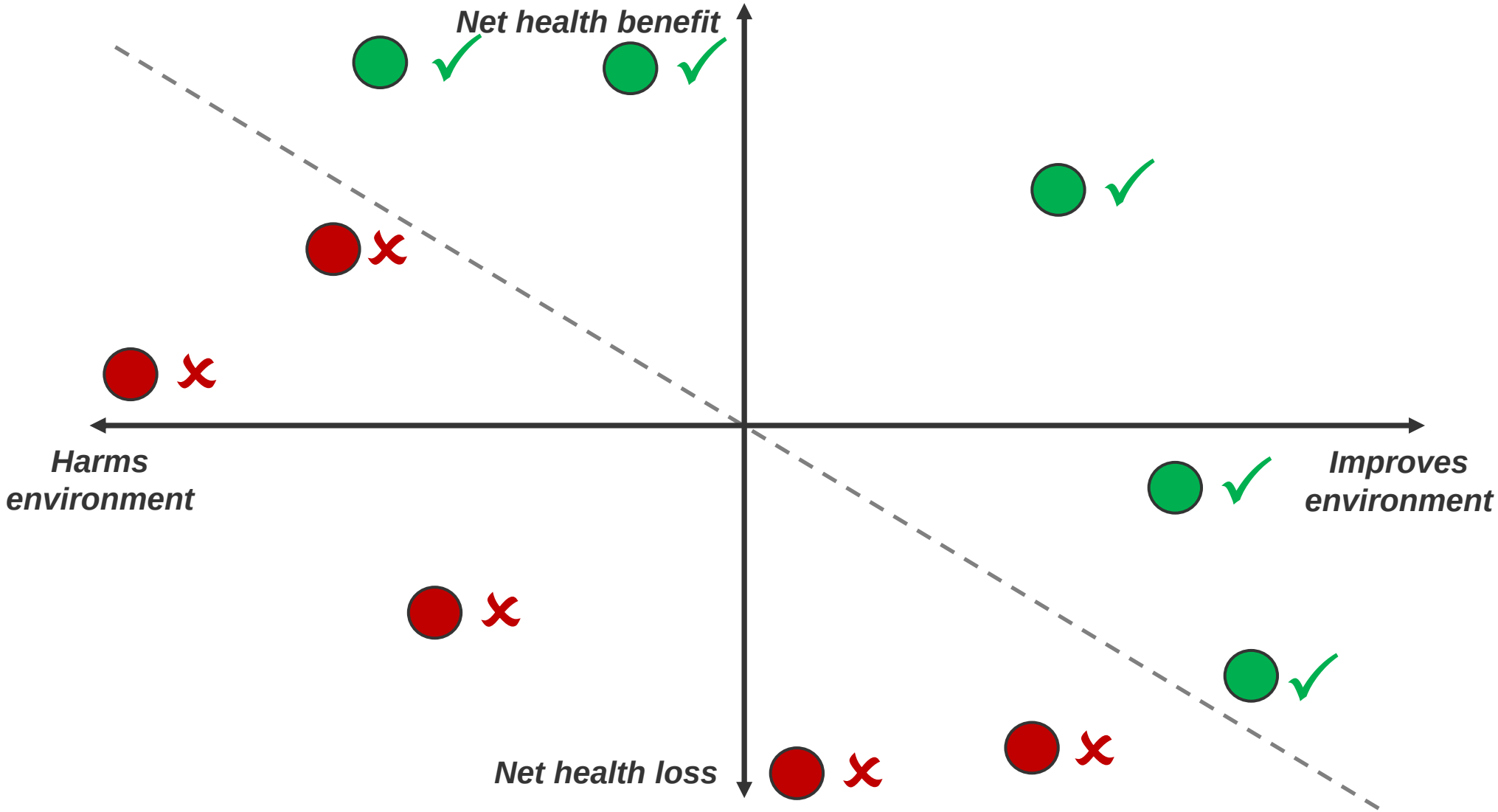
Trading off health and the environment



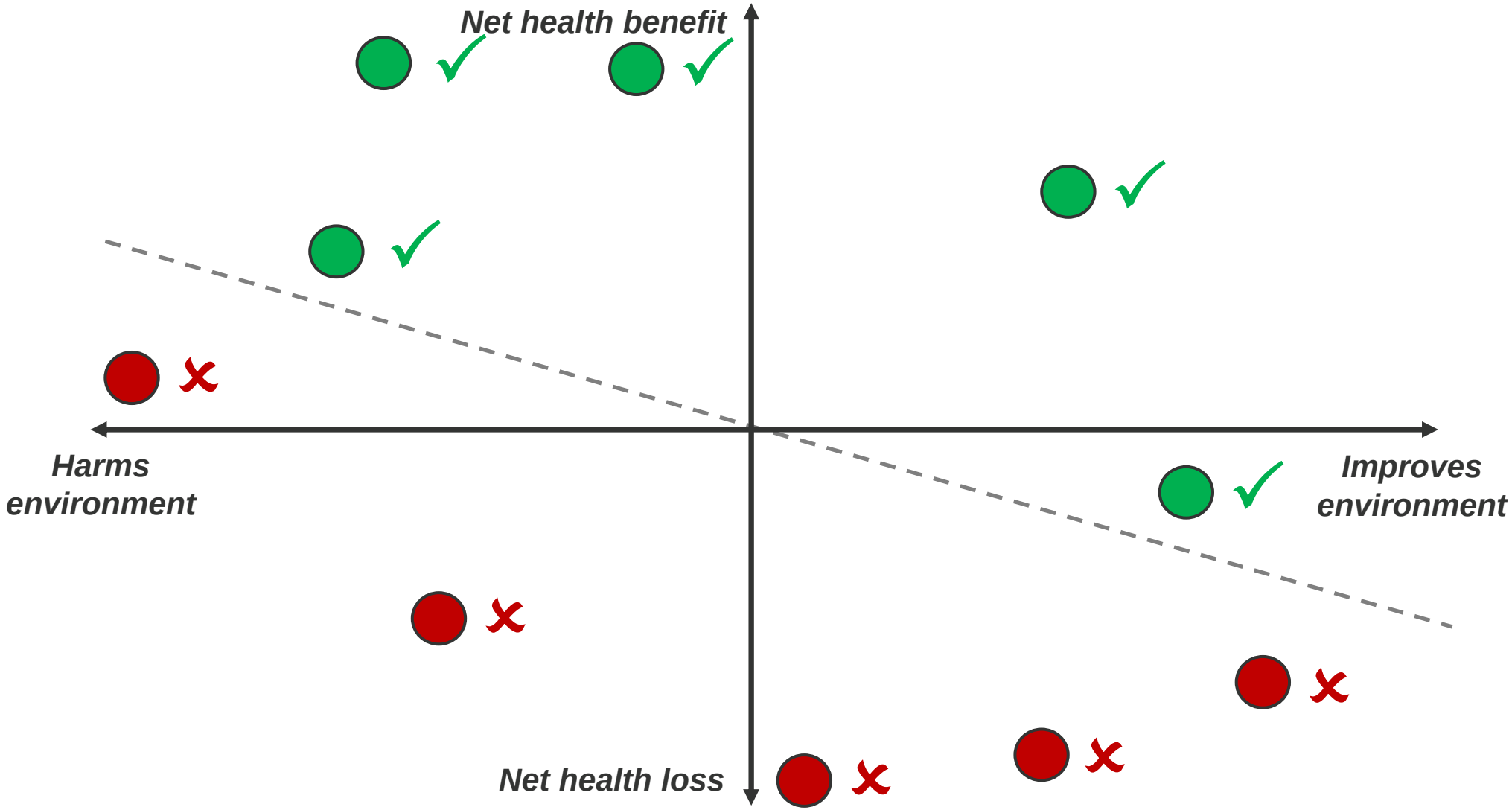
Trading off health and the environment



Trading off health and the environment



Trading off health and the environment



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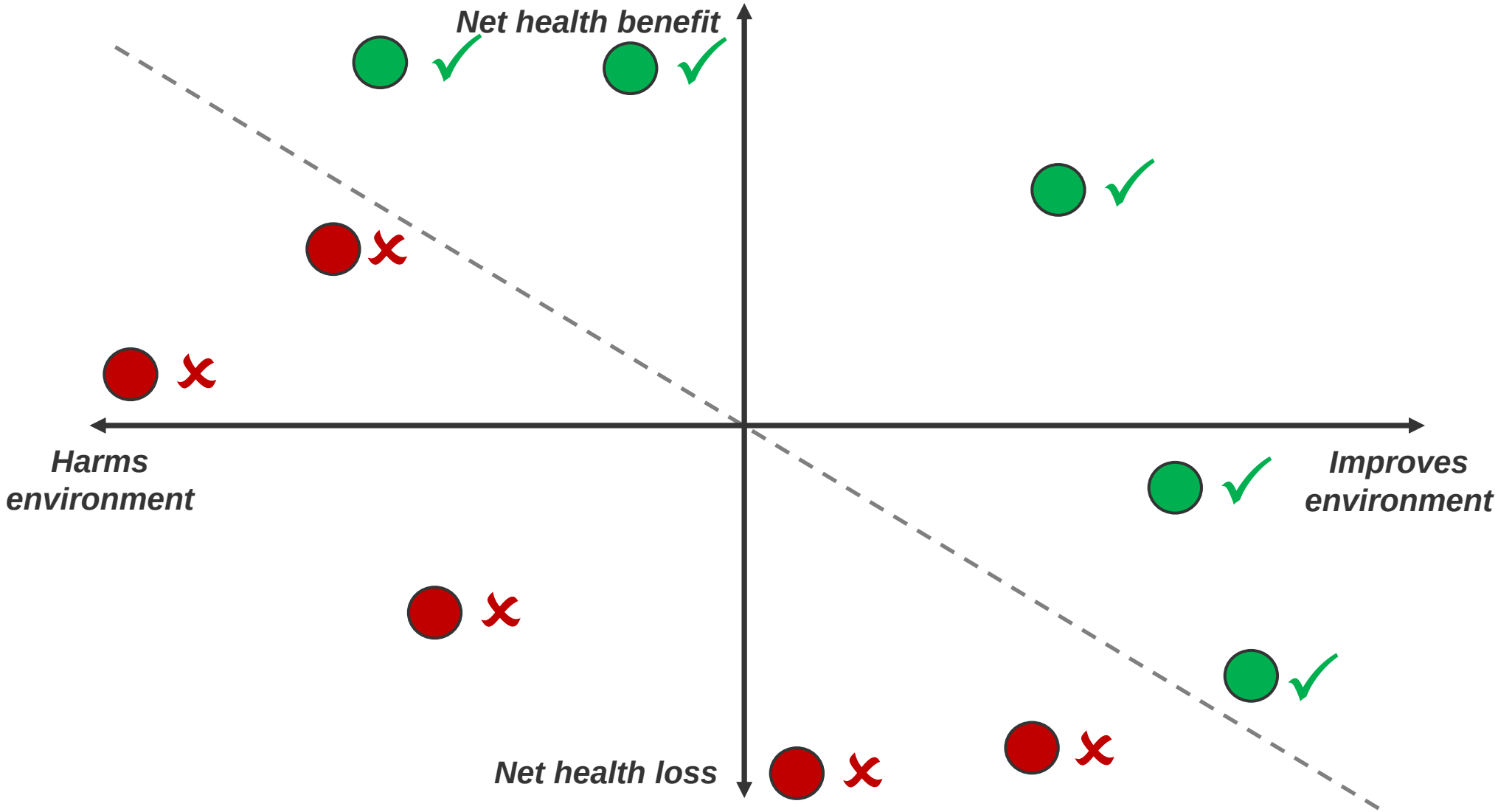
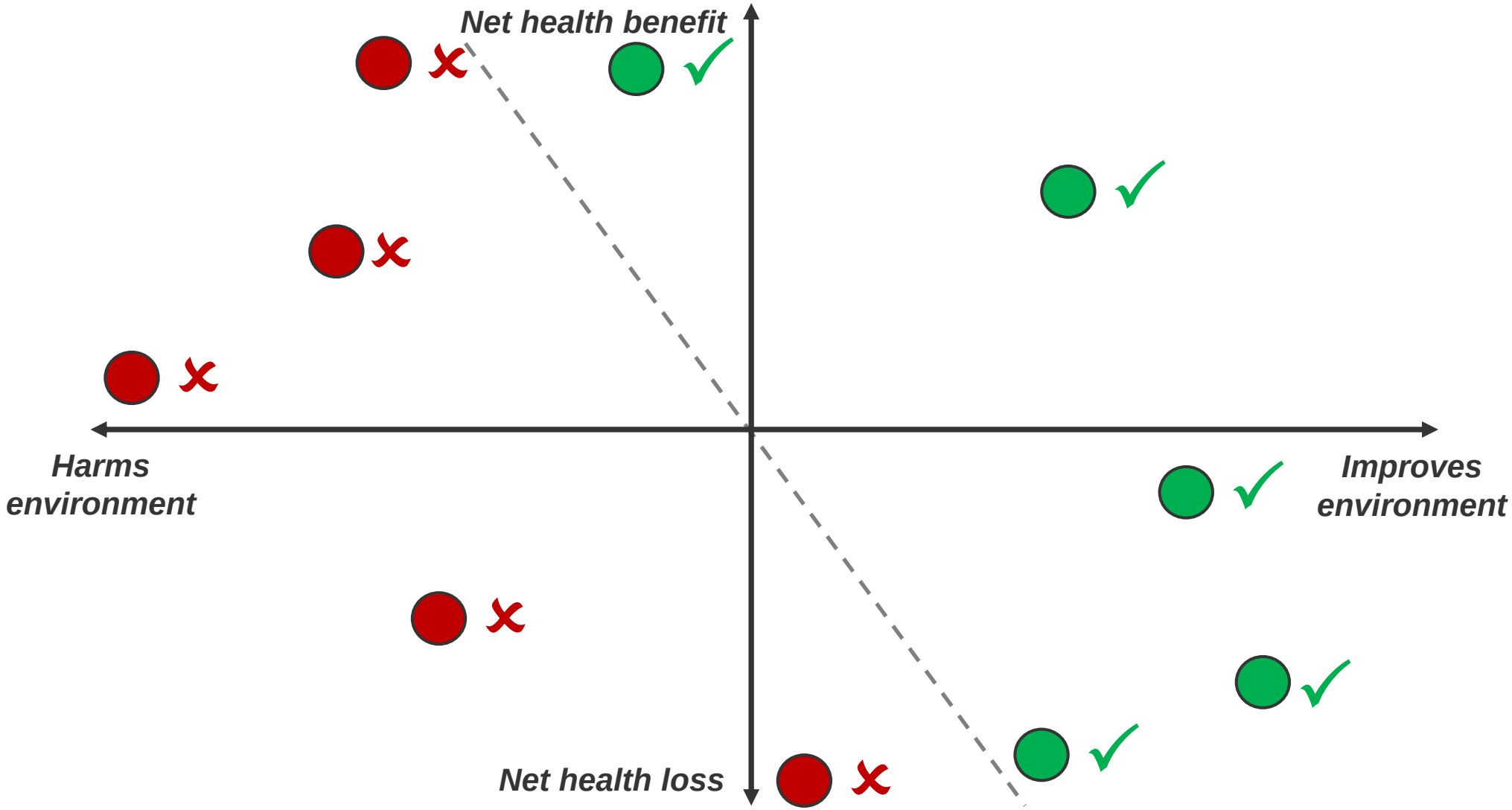


Trading off health and the environment



Health vs environment: preferences

- As noted above, there can sometimes be ‘trade-offs’ between outcomes produced by a new healthcare intervention
- For example, an intervention might improve health, but cause harm to the environment
- An intervention might be less harmful, but cost more (and thus take funding away from other resources that might have improved health)
- Very little (if any) evidence exists as to the public’s preferences for such trade offs

Health vs environment: preferences

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Discrete choice experiments (example)

Option A	
Life expectancy	12 years
CO_2 emissions	High
Impact on resources	High impact
Impact	Overseas only

Option B	
Life expectancy	14 years
CO_2 emissions	Medium
Impact on resources	Medium
Impact	Global

Health vs environment: preferences

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- A pilot study conducted by YHEC in 2023 concluded that it is feasible to ask the public about such trade-offs
- N = 508

- Willing **to lose** 0.75 years of life expectancy for a 5% **reduction** in CO_2 emissions
- Willing to accept a 5% **increase** in CO_2 emissions for a 1.59-year **increase** in life expectancy

- Willing **to lose** 1.55 years of life expectancy to **save** 100 species from becoming extinct
- Willing to accept 100 species **going extinct** for a 2.88-year **increase** in life expectancy

- Results varied depending on the location of the environmental impact (e.g. UK vs overseas)

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Challenges

What data do we need to make these decisions?

Scenario	Analysis requirement
Head to head single technology appraisal (STA)	Two impact assessments (one for each treatment)
STA with multiple comparators	Multiple impact assessments (one for each intervention)
Multiple technology appraisal (MTA)	Multiple impact assessments (one for each intervention)
Medical technology evaluation	Assessment for each technology and potential changes in the technology (since medical technologies tend to evolve over time, unlike pharmaceuticals)
Clinical guideline	One assessment for each decision point in the clinical guideline (with a separate analysis for each alternative at each decision point)
Public health evaluation	One assessment for each decision point in the clinical guideline (with a separate analysis for each alternative at each decision point)

Plus the impact of displaced funding

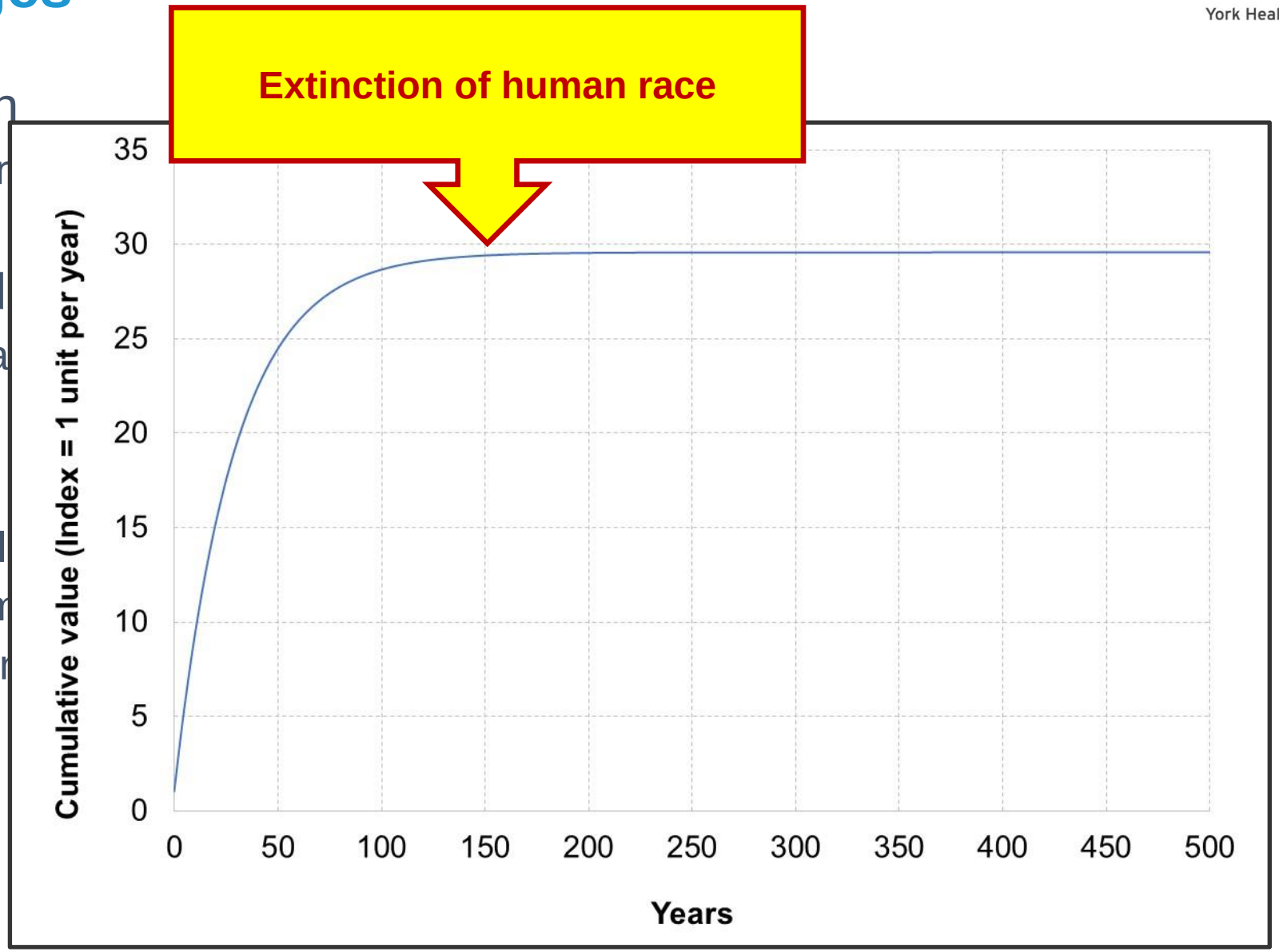
No guidance how to handle cases where we have strong evidence for one intervention but not others

Other challenges

- Who is responsible for *producing* the evidence?
  - Risk of bias / non-reporting
- Who is responsible for *critiquing* the evidence
  - Appropriate skills
- What are the boundaries?
  - Geographic borders
  - Time horizons
- Can everything be quantified and valued?
  - GHGs, pollution, resources - maybe
  - Biodiversity?

Other challenges

- Triage approach
  - Defining “substar
- Uncertainty and
  - Life cycle approa
- Discounting
  - Intergenerational
  - Treasury recomm
  - However, this car



Two main approaches to including sustainability

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DELIBERATIVE PROCESS

- A committee might use environmental evidence alongside other evidence
- Similar to inequalities
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- No transparency as when the environmental impact should / should not change the decision
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REQUIRES A DECISION RULE

- How much health loss should be traded in order to gain one ‘unit’ of environmental benefit (and vice versa)?
- 1 QALY = ?

Example of parallel assessment checklist

Question	Response
▪ Is the technology or treatment pathway likely to impact upon GHG emissions, waste, water pollution, biodiversity, resource depletion or air pollution?	
▪ Has the company / guideline developer discussed the likely *direction* of the impact?	
▪ Has the company / guideline developer discussed the likely *magnitude* of the impact?	
▪ Has the company / guideline developer considered all downstream impacts of the recommendation (i.e. will this increase / decrease other healthcare resource use)?	
▪ Have estimates been provided for the comparator treatments and/or pathways?	
▪ If not, is the environmental impact for the investigated treatment likely to be higher or lower than that of the comparators?	
▪ If quantitative estimates have been provided, were they derived from appropriate sources?	
▪ Has uncertainty around the estimates been addressed appropriately?	

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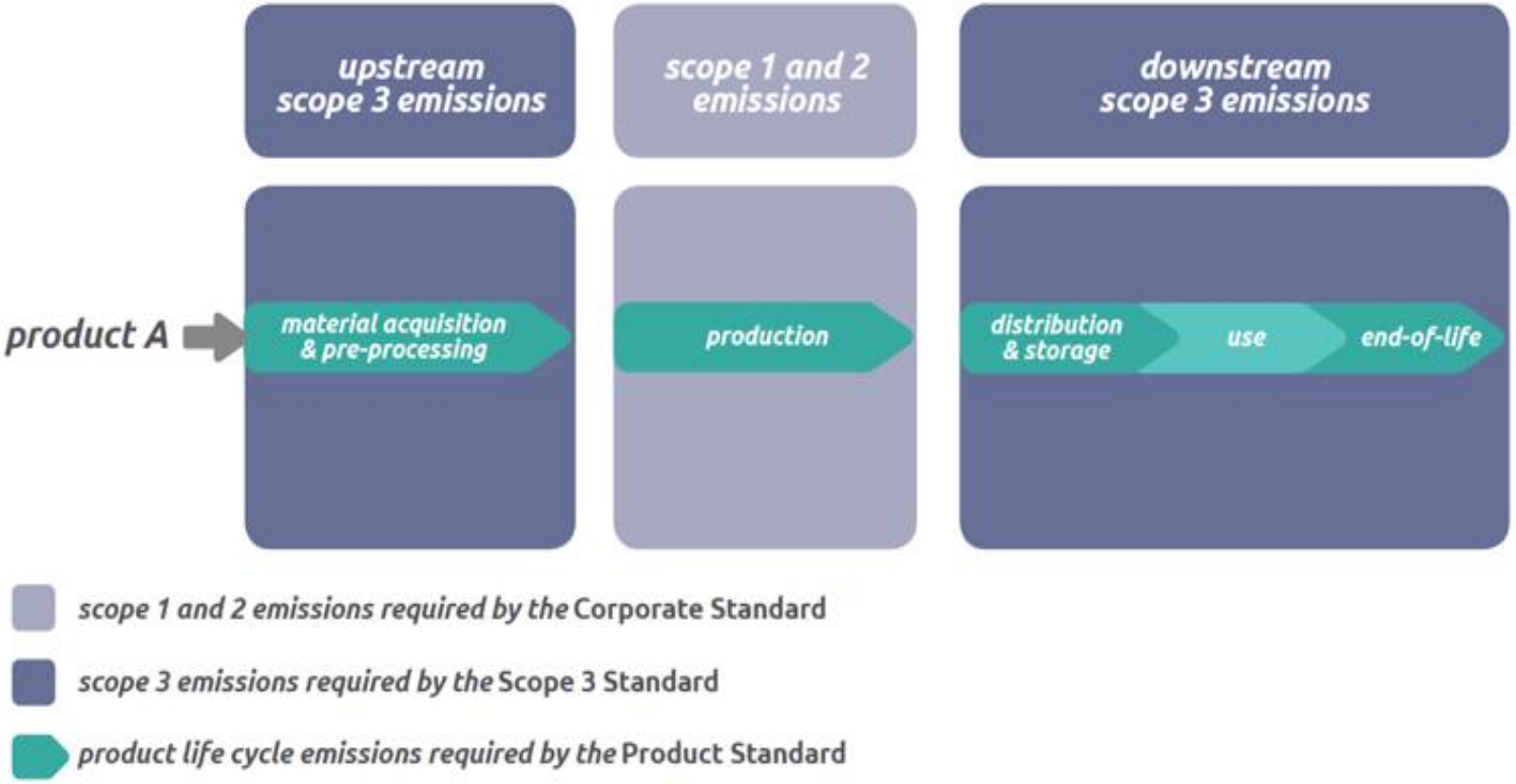
Environmental life cycle assessment (LCA)

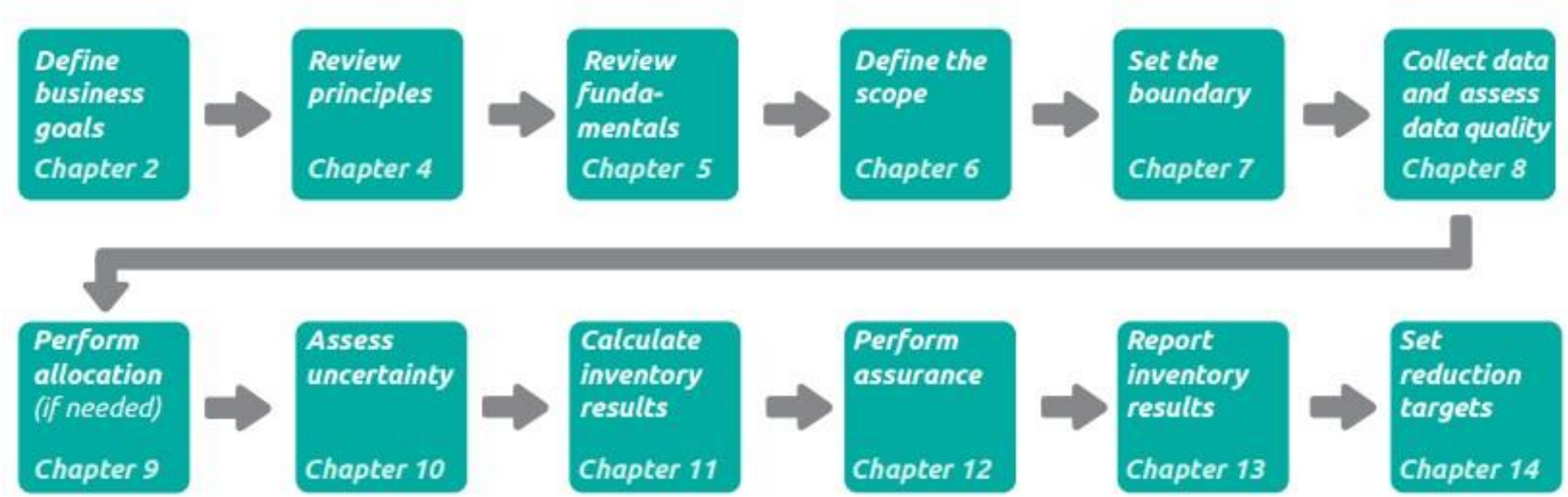
Environmental life cycle assessment (LCA)

- LCA is a framework for measuring the environmental impact of an intervention
- Existing standards include GHG protocol standards; ISO14001 standards; ISO14067 standards; PAS 2050
- GHG Accounting Sector Guidance for Pharmaceutical Products and Medical Devices



Source: The boundary of a product LCA outlined in the GHG Protocol standards (World Resource Institute 2011)

Environmental life cycle assessment (LCA)



Overview of steps of product accounting and reporting. World Resources Institute (2011) Greenhouse gas protocol. [Product life cycle reporting and accounting standards]

Environmental life cycle assessment (LCA)

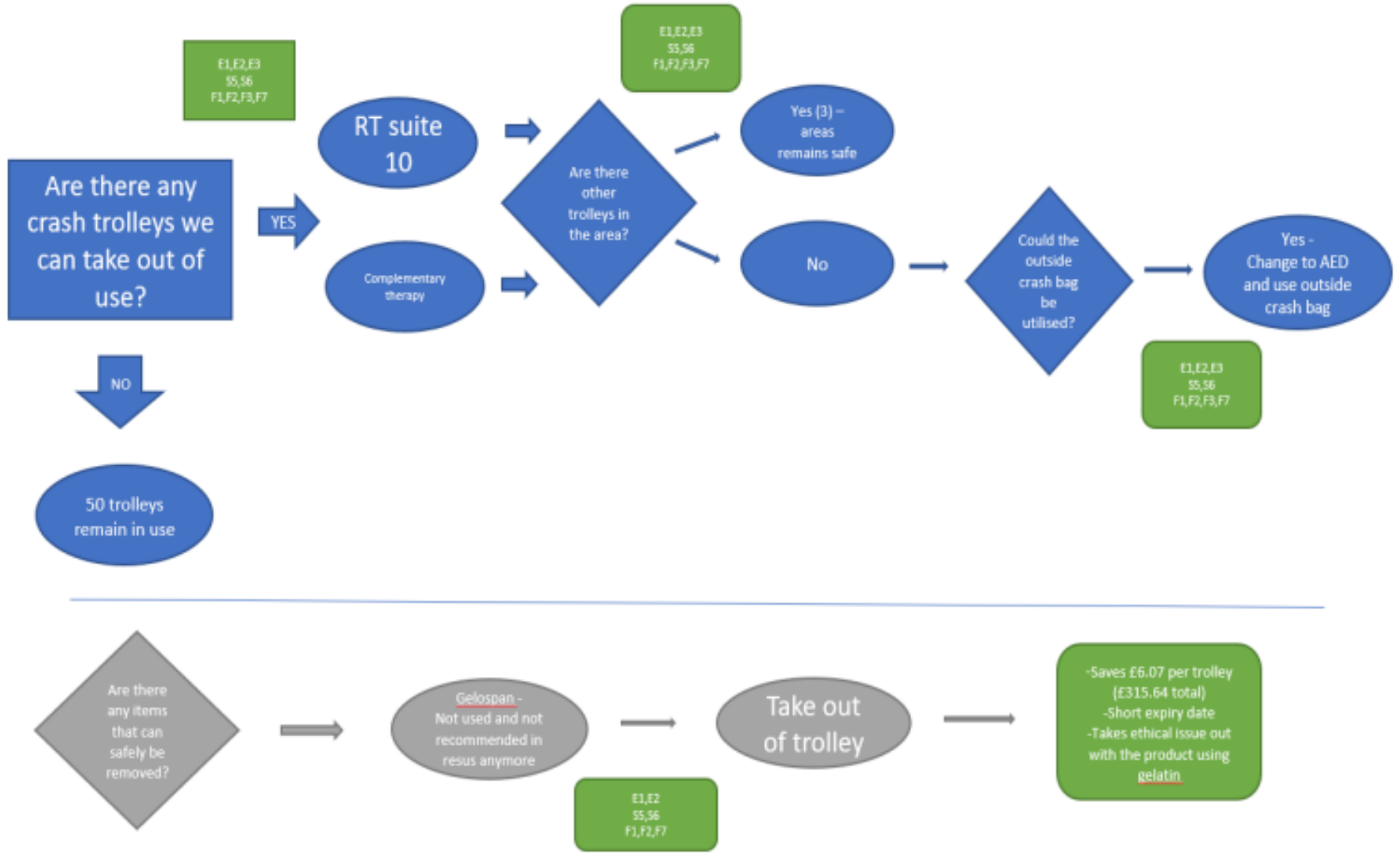
- Part of the LCA is a life cycle impact assessment (LCIA). There are various impacts to consider with the LCIA:

  - Human heath impact
  - Greenhouse gas emissions
  - Waste
  - Water pollution
  - Air pollution
  - Depletion of resources, for example, water, fossil fuels, finite rare elements
  - Loss of biodiversity
  - Animal health impact
  - Animal welfare (QALY)

Environmental life cycle assessment (LCA)

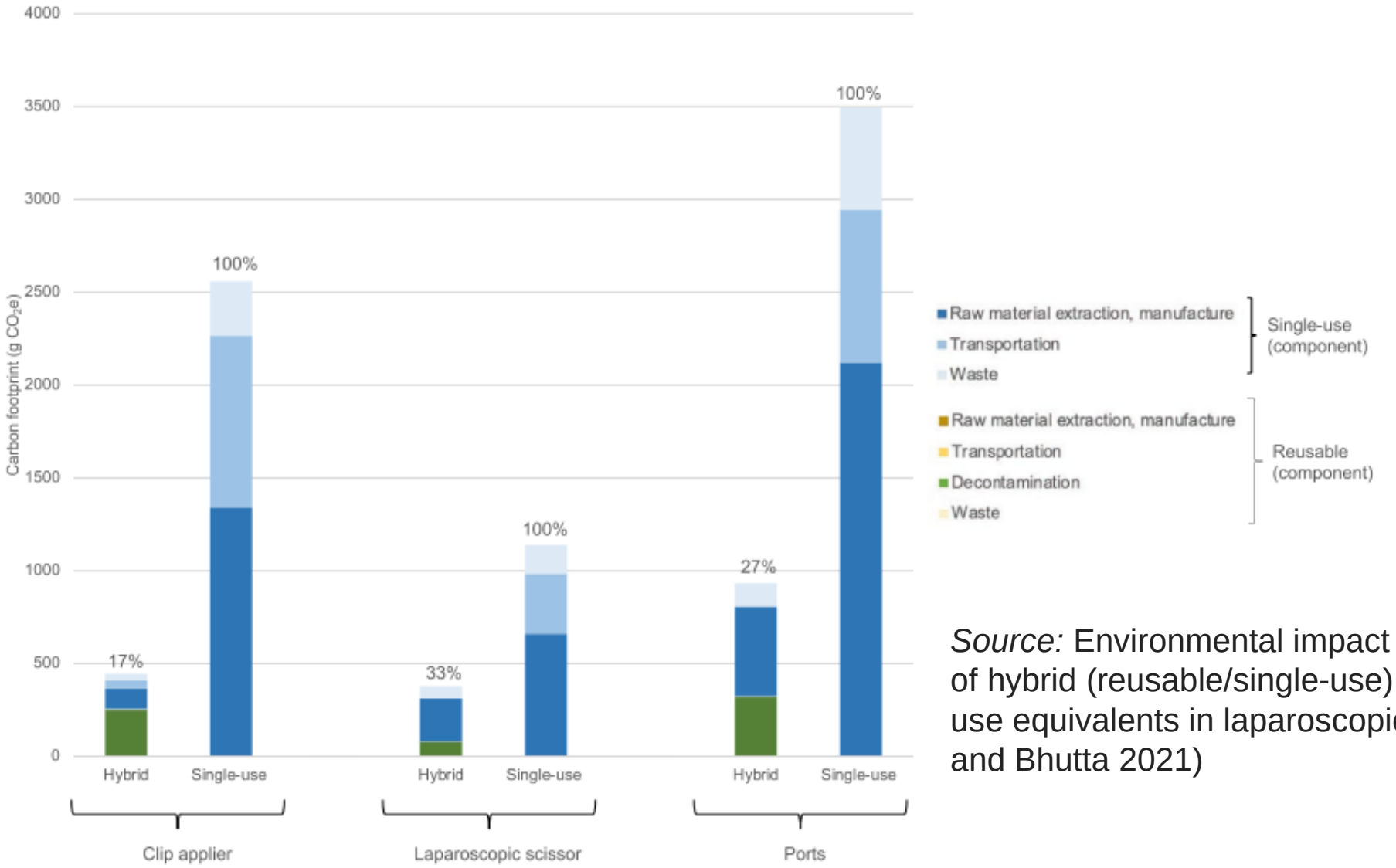
- Two methodological approaches used to perform either a carbon footprint or LCA environmental impact evaluation
- ‘Top-down’ environmentally extended input-output (EEIO) model applying a monetary cost of a unit to estimate environmental impact
- ‘Bottom-up’ process-based method involves collecting data on all the component processes underpinning the unit of interest
- Hybrid methods are acceptable exist to either incorporate the granularity of the process-based approach in conjunction with EEIO models, or where top-down approaches for attributable components for which process data cannot be generated

Process based environmental life cycle assessment (LCA)



Source: An example of a process map for a LCA. The Christie, Centre for Sustainable Healthcare competition winners, report (2022)

LCA and life cycle costing (LCC) of health technology



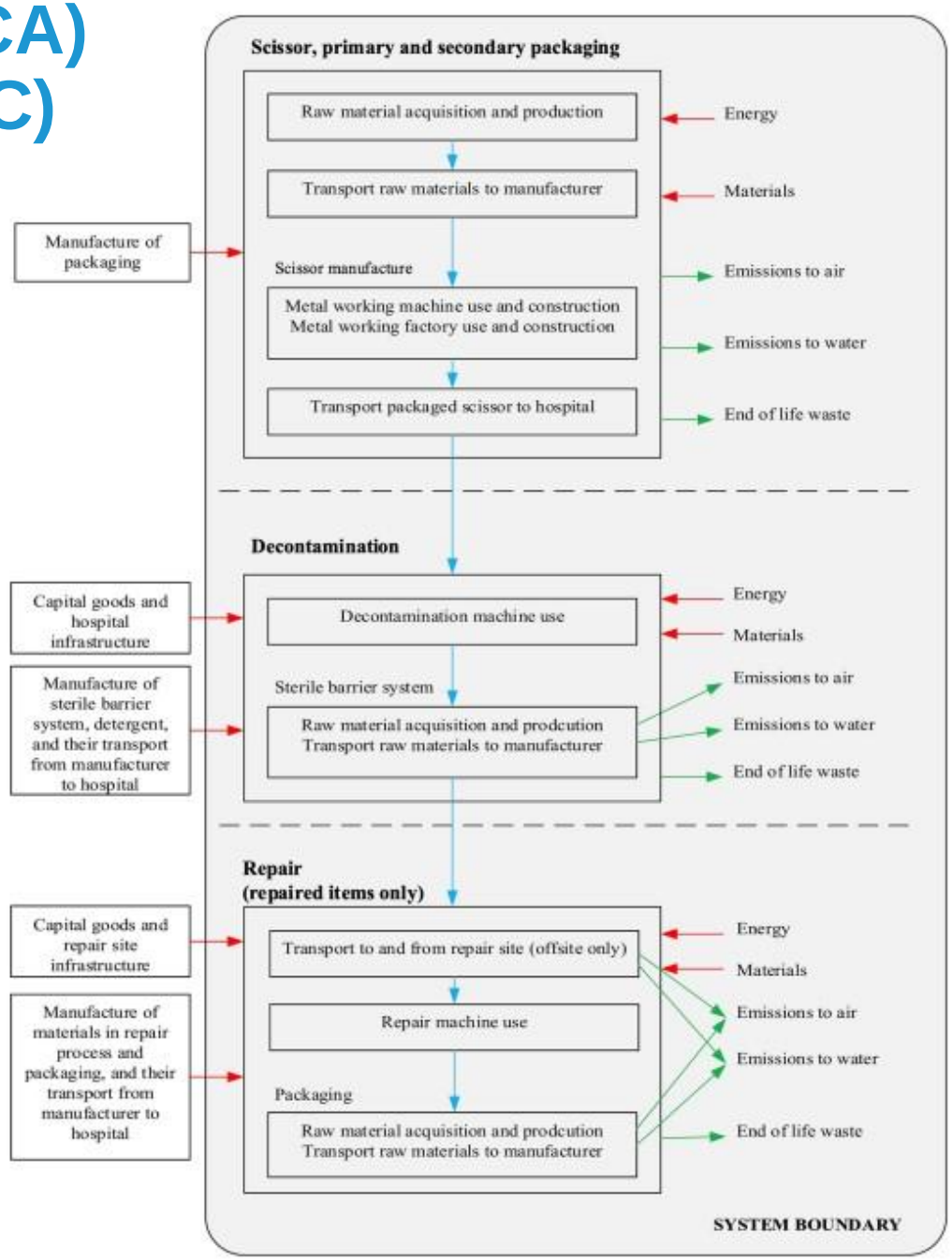
Source: Environmental impact and life cycle financial cost of hybrid (reusable/single-use) instruments versus single-use equivalents in laparoscopic cholecystectomy (Rizan and Bhutta 2021)

LCA and life cycle costing LCC of health technology

Damage category	Unit	Laparoscopic clip applier		Laparoscopic scissors		Ports		Total (Normalised results)	
		Hybrid	Single-use	Hybrid	Single-use	Hybrid	Single-use	Hybrid	Single-use
Human health	DALY	$1.09e^{-6}$	$6.30e^{-6}$	$1.28e^{-6}$	$2.90e^{-6}$	$1.67e^{-6}$	$6.13e^{-6}$	$4.04e^{-6}$ ($1.7e^{-4}$)	$1.53e^{-5}$ ($6.45e^{-4}$)
Ecosystems	species.yr	$1.96e^{-9}$	$1.24e^{-8}$	$1.84e^{-9}$	$5.22e^{-9}$	$3.67e^{-9}$	$1.36e^{-8}$	$7.47e^{-9}$ ($1.04e^{-5}$)	$3.12e^{-8}$ ($4.36e^{-5}$)
Resources	US $	0.0464	0.2944	0.0314	0.1176	0.0853	0.344473	$1.63e^{-1}$ ($5.82e^{-6}$)	$7.56e^{-1}$ ($2.7e^{-5}$)

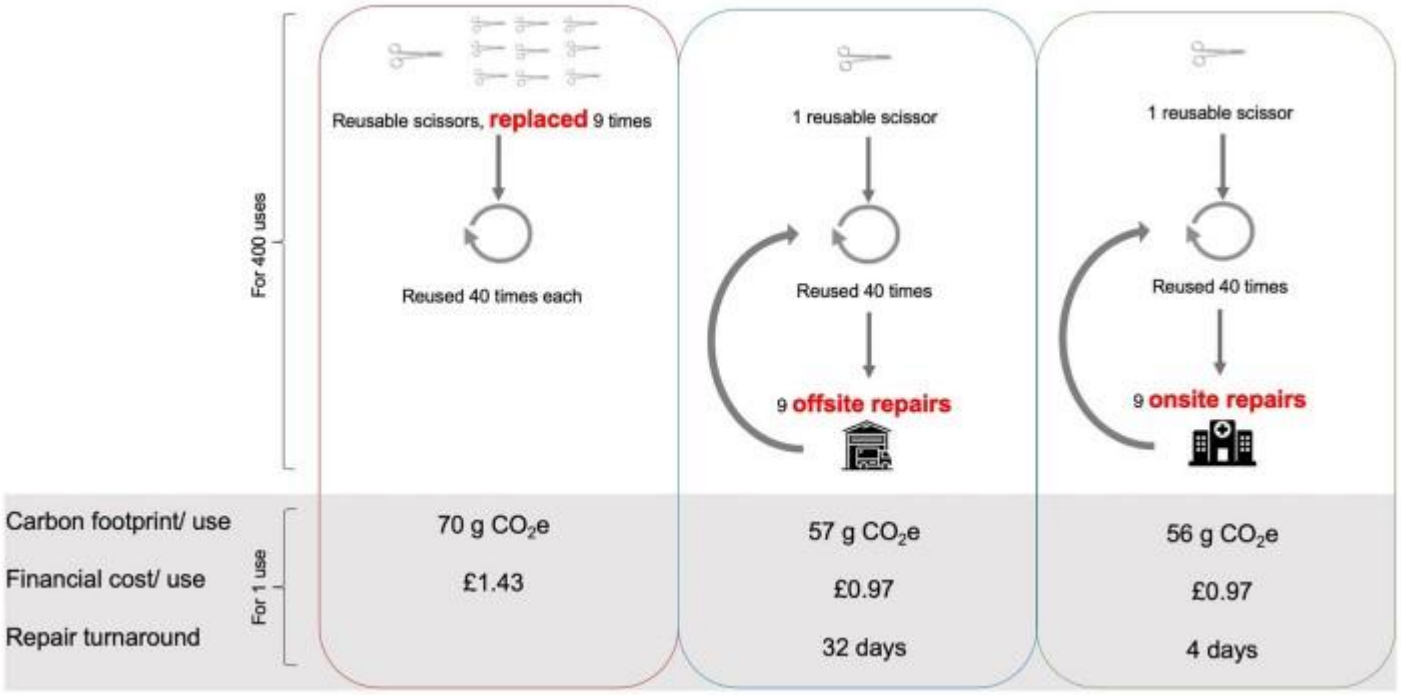
Source: Environmental impact and life cycle financial cost of hybrid (reusable/single-use) instruments versus single-use equivalents in laparoscopic cholecystectomy (Rizan and Bhutta 2021)

Life cycle assessment (LCA) and life cycle costing (LCC) of health technology



Life cycle assessment and life cycle cost of repairing surgical scissors (Rizan et al., 2022)

Life cycle assessment (LCA) and life cycle costing (LCC) of health technology



Life cycle assessment and life cycle cost of repairing surgical scissors (Rizan et al., 2022)

Single use scissors: 835g CO2e/use, £4.26/use

Reusable scissors: 64g CO2e/use, £1.43/use

Summary of approaches to support developing environmental impact methods appropriate for HTA

YHEC
York Health Economics Consortium

- Use standards and guidance
- Hybrid methodology
- Transparency and explicit in methods
- Quantitative and qualitative methods
- Primary and secondary data
- Broad environmental outcomes
- Can data be extrapolated?
- Multidisciplinary collaboration
- Care pathway LCA is the goal!
- Life cycle costing (LCC)

Potential next steps

- Is there scope to collaborate with other industry suppliers? Perhaps the same care pathway LCA where both health technologies contribute to sustainable development?
- Utilise the Centre for Sustainable Healthcare (CSH) resources, courses and networks
- Keep abreast of the developments, reports and guidance published amongst healthcare professional bodies and trade unions in healthcare sustainable development
- Look out for any further webinars and educational events from YHEC – sign up to receiving information about events
- Contact melissa.pegg@york.ac.uk to enquire about collaboration opportunities with YHEC

Thank you for listening
Any questions please?

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